CLAIMS

What is claimed is:

1. A method of generating RAKE combining weights in a RAKE receiver, the method comprising:

obtaining individual finger output signals by despreading a received signal in each of two or more RAKE fingers;

generating channel estimates corresponding to the RAKE fingers;

determining combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers; and

computing RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics.

2. The method of claim 1, wherein determining combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers comprises estimating correlations of channel coefficients across the RAKE fingers, and determining estimation error and noise correlations across the RAKE fingers.

3. The method of claim 1, wherein determining combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers comprises estimating means of the channel coefficients for the RAKE fingers, and determining estimation error covariance and noise covariance across the RAKE fingers.

4. The method of claim 3, wherein determining combining statistics further comprises determining channel coefficient covariance across the RAKE fingers.

5. The method of claim 1, wherein generating channel estimates corresponding to the RAKE fingers comprises smoothing despread pilot values.

6. The method of claim 5, wherein determining noise statistics comprises determining noise cross-correlation based on the despread pilot values and scaling the noise cross-correlation based on a smoothing factor to obtain an estimation error cross-correlation as the channel estimation error statistics.

7. The method of claim 1, wherein generating channel estimates corresponding to the RAKE fingers comprises generating channel estimates from a received pilot signal, and wherein determining noise statistics for the RAKE fingers comprises generating a noise cross-correlation matrix from the received pilot signal.

8. The method of claim 1, wherein computing RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics comprises:

scaling a channel coefficient measurement vector based on channel coefficient covariance and estimation error cross-correlation determined for the RAKE fingers;

adding a term to the scaled channel coefficient measurement vector based on means of the channel coefficients determined for the RAKE fingers; and

augmenting a noise covariance matrix representing the noise covariance based on the channel coefficient covariance and an estimation error covariance determined for the RAKE fingers.

9. The method of claim 1, wherein computing RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics comprises:

scaling a channel coefficient measurement vector based on channel coefficient cross-correlation and estimation error cross-correlation determined for the RAKE fingers; and

using the scaled channel coefficient measurement vector and a noise correlation matrix determined for the RAKE fingers to solve for the combining weights.

10. The method of claim 1, wherein determining channel coefficient statistics comprises determining means of the channel coefficients based on smoothing the channel estimates.

11. The method of claim 10, wherein smoothing the channel estimates comprises smoothing values in a channel estimate coefficient vector according to an exponential smoothing filter.

12. The method of claim 1, wherein determining channel coefficient statistics comprises determining channel coefficient statistics across the RAKE fingers such that combining weight generation is compensated for correlations in channel coefficients across the RAKE fingers.

13. The method of claim 12, further comprising determining the channel coefficient statistics based on nominal channel coefficient statistics corresponding to one or more default fading models.

14. The method of claim 1, further comprising receiving signals on two or more receiver antennas.

15. The method of claim 14, wherein determining combining statistics comprises determining noise and estimation error correlations and channel coefficient correlations jointly across the receiver antennas.

16. The method of claim 14, wherein determining combining statistics comprises determining noise and estimation error correlations separately for each receiver antenna and determining channel coefficient correlations jointly across the receiver antennas.

17. The method of claim 14, further comprising assigning a set of RAKE fingers to a received signal from each receiver antenna and determining the combining statistics separately for each set of RAKE fingers.

18. The method of claim 1, further comprising receiving signals from two or more transmit antennas.

19. The method of claim 18, wherein determining combining statistics comprises determining noise and estimation error correlations and channel coefficient correlations jointly across the transmit antennas.

20. The method of claim 18, wherein determining combining statistics comprises determining noise and estimation error correlations separately for each transmit antenna and determining channel coefficient correlations jointly across the transmit antennas.

21. The method of claim 18, further comprising assigning a set of RAKE fingers to a received signal corresponding to each transmit antenna and determining the combining statistics separately for each set of RAKE fingers.

22. The method of claim 1, wherein computing RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics comprises selectively computing the combining weights based on the channel estimates and the combining statistics.

23. The method of claim 22, wherein selectively computing the combining weights based on the channel estimates and the combining statistics comprises using the combining statistics to compute the combining weights in a first mode, and using a subset of the combining statistics in a second mode.

24. The method of claim 23, further comprising selecting between the first and second modes based on determining a normalized fading correlation.

25. A RAKE receiver circuit comprising:

a RAKE processor circuit configured to

obtain individual finger output signals by despreading a received signal in each of two or more RAKE fingers;

generate channel estimates corresponding to the RAKE fingers;

determine combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers; and

compute RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics.

26. The circuit of claim 25, wherein the RAKE processor circuit comprises a channel coefficient estimator configured to estimate channel coefficients for the RAKE fingers, a channel coefficient statistic estimator configured to estimate channel coefficient statistics, and a noise and error statistic estimator configured to estimate noise and channel estimation error statistics.

27. The circuit of claim 26, wherein the RAKE processor circuit further comprises a combining weight generator to compute the RAKE combining weights.

28. The circuit of claim 25, wherein the RAKE processor circuit is configured to determine combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers by estimating correlations of channel coefficients across the RAKE fingers, and determining estimation error and noise correlations across the RAKE fingers.

29. The circuit of claim 25, wherein the RAKE processor circuit is configured to determine combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers by estimating means of the channel coefficients for the RAKE fingers, and determining estimation error covariance and noise covariance across the RAKE fingers.

30. The circuit of claim 29, wherein the RAKE processor circuit is configured to determine combining statistics further by determining channel coefficient covariance across the RAKE fingers.

31. The circuit of claim 25, wherein the RAKE processor circuit is configured to generate channel estimates corresponding to the RAKE fingers by smoothing despread pilot values.

32. The circuit of claim 31, wherein the RAKE processor circuit is configured to determine noise statistics comprises determining noise cross-correlation based on the despread pilot values and to scale the noise cross-correlation based on a smoothing factor to obtain an estimation error cross-correlation as the channel estimation error statistics.

33. The circuit of claim 25, wherein the RAKE processor circuit is configured to generate channel estimates corresponding to the RAKE fingers by generating channel estimates from a received pilot signal, and wherein the RAKE processor circuit is configured to determine noise statistics for the RAKE fingers by generating a noise cross-correlation matrix from the received pilot signal.

34. The circuit of claim 25, wherein the RAKE processor circuit is configured to compute RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics by:

scaling a channel coefficient measurement vector based on channel coefficient covariance and estimation error cross-correlation determined for the RAKE fingers;

adding a term to the scaled channel coefficient measurement vector based on means of the channel coefficients determined for the RAKE fingers; and

augmenting a noise covariance matrix representing the noise covariance based on the channel coefficient covariance and an estimation error covariance determined for the RAKE fingers.

35. The circuit of claim 25, wherein the RAKE processor circuit is configured to compute RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics by:

scaling a channel coefficient measurement vector based on channel coefficient and estimation error cross-correlation determined for the RAKE fingers; and

using the scaled channel coefficient measurement vector and a noise correlation matrix determined for the RAKE fingers to solve for the combining weights.

36. The circuit of claim 25, wherein the RAKE processor circuit is configured to determine channel coefficient statistics by determining means of the channel coefficients based on smoothing the channel estimates.

37. The circuit of claim 36, wherein the RAKE processor circuit is configured to smooth the channel estimates by smoothing values in a channel estimate coefficient vector according to an exponential smoothing filter.

38. The circuit of claim 25, wherein the RAKE processor circuit is configured to determine channel coefficient statistics by determining channel coefficient statistics across the RAKE fingers such that combining weight generation is compensated for correlations in channel coefficients across the RAKE fingers.

39. The circuit of claim 38, wherein the RAKE processor circuit is configured to determine the channel coefficient statistics based on nominal channel coefficient statistics corresponding to one or more default fading models.

40. The circuit of claim 39, further comprising a memory circuit to store data corresponding to the one or more default fading models.

41. The circuit of claim 25, wherein the RAKE processor circuit is configured to process signals from two or more receiver antennas.

42. The circuit of claim 41, wherein the RAKE processor circuit is configured to determine combining statistics by determining noise and estimation error correlations and channel coefficient correlations jointly across the receiver antennas.

43. The circuit of claim 41, wherein the RAKE processor circuit is configured to determine combining statistics by determining noise and estimation error correlations separately for each receiver antenna and to determine channel coefficient correlations jointly across the receiver antennas.

44. The circuit of claim 41, wherein the RAKE processor circuit is configured to assign a set of RAKE fingers to a received signal from each receiver antenna and determine the combining statistics separately for each set of RAKE fingers.

45. The circuit of claim 25, wherein the received signal comprises signals received from two or more transmit antennas.

46. The circuit of claim 45, wherein the RAKE processor circuit is configured to determine the combining statistics by determining noise and estimation error correlations and channel coefficient correlations jointly across the signals from the two or more transmit antennas.

47. The circuit of claim 45, wherein the RAKE processor circuit is configured to determine the combining statistics by determining noise and estimation error correlations separately for each transmit antenna and determining channel coefficient correlations jointly across the signals from the two or more transmit antennas.

48. The circuit of claim 45, wherein the RAKE processor circuit is configured to assign a set of RAKE fingers to a received signal corresponding to each transmit antenna and determining the combining statistics separately for each set of RAKE fingers.

49. The circuit of claim 25, wherein the RAKE processor circuit is configured to compute RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics by selectively computing the combining weights based on the channel estimates and the combining statistics.

50. The circuit of claim 49, wherein the RAKE processor circuit is configured to selectively compute the combining weights based on the channel estimates and the combining statistics

comprises by using the combining statistics to compute the combining weights in a first mode, and using a subset of the combining statistics in a second mode.

51. The method of claim 50, wherein the RAKE processor circuit is configured to select between the first and second modes based on determining a normalized fading correlation.

52. A computer readable medium storing a computer program comprising:

program instructions to obtain individual finger output signals by despreading a received signal in each of two or more RAKE fingers;

program instructions to generate channel estimates corresponding to the RAKE fingers;

program instructions to determine combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers; and

program instructions to compute RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics.

53. The computer readable medium of claim 52, wherein the program instructions to generate channel estimates corresponding to the RAKE fingers comprise program instructions to generate a channel estimate vector based on smoothing despread pilot values.

54. The computer readable medium of claim 53, wherein the program instructions to determine noise statistics comprise program instructions to determine noise cross-correlations for the RAKE fingers, and wherein the program instructions to determine channel estimation error statistics comprise program instructions to determine channel estimation error cross-correlations by scaling the noise cross-correlation matrix according to a smoothing factor associated with generating the channel estimate vector.

55. A mobile terminal comprising:

a transmitter to transmit wireless signals to one or more remote receivers;

a receiver to receive wireless signals from one or more remote transmitters, said receiver comprising a RAKE receiver circuit configured to:

obtain individual finger output signals by despreading a received signal in each of two or more RAKE fingers;

generate channel estimates corresponding to the RAKE fingers;

determine combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers; and

compute RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics.

56. The mobile terminal of claim 55, wherein the RAKE receiver circuit comprises a channel coefficient estimator configured to estimate channel coefficients for the RAKE fingers, a channel coefficient statistics estimator configured to estimate channel coefficient statistics for the RAKE fingers, and a noise and error statistics estimator configured to estimate noise statistics and channel estimation error statistics for the RAKE fingers.

57. The mobile terminal of claim 56, wherein the channel coefficient statistics estimator is configured to estimate cross-correlations in channel coefficients for two or more of the RAKE fingers.

58. The mobile terminal of claim 56, wherein the channel coefficient statistics estimator is configured to estimate means of channel coefficients for each of two or more of the RAKE fingers.

59. The mobile terminal of claim 56, wherein the noise and error statistics estimator is configured to estimate noise cross-correlations and channel estimation error cross-correlations across two or more of the RAKE fingers.

60. The mobile terminal of claim 55, wherein the RAKE receiver circuit further comprises a combining weight generator to compute the RAKE combining weights.

61. The mobile terminal of claim 55, wherein the RAKE receiver circuit is configured to generate channel estimates, determine combining statistics and compute combining weights jointly for one or more received diversity signals.

62. The mobile terminal of claim 55, wherein the RAKE receiver circuit is configured to generate channel estimates, determine combining statistics and compute combining weights for one or more received diversity signals according to a mixed joint/separate processing wherein channel coefficient cross-correlations are computed jointly across the diversity signals and noise and channel estimation error cross-correlations are computed separately on a per diversity signal basis.

63. The mobile terminal of claim 55, wherein the RAKE receiver circuit is configured to determine combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers by estimating means of the channel coefficients for the RAKE fingers, and determining estimation error covariance and noise covariance across the RAKE fingers.

64. The mobile terminal of claim 63, wherein the RAKE receiver circuit is configured to determine combining statistics further by determining channel coefficient covariance across the RAKE fingers.

65. The mobile terminal of claim 55, wherein the RAKE receiver circuit is configured to generate channel estimates corresponding to the RAKE fingers by smoothing despread pilot values.

66. The mobile terminal of claim 65, wherein the RAKE receiver circuit is configured to determine noise statistics comprises determining noise cross-correlation based on the despread pilot values and to scale the noise cross-correlation based on a smoothing factor to obtain an estimation error cross-correlation as the channel estimation error statistics.

67. The mobile terminal of claim 55, wherein the RAKE receiver circuit is configured to generate channel estimates corresponding to the RAKE fingers by generating channel estimates from a received pilot signal, and wherein the RAKE receiver mobile terminal is configured to determine noise statistics for the RAKE fingers by generating a noise cross-correlation matrix from the received pilot signal.

68. The mobile terminal of claim 55, wherein the RAKE receiver circuit is configured to compute RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics by:

scaling a channel coefficient measurement vector based on channel coefficient covariance and estimation error cross-correlation determined for the RAKE fingers;

adding a term to the scaled channel coefficient measurement vector based on means of the channel coefficients determined for the RAKE fingers; and

augmenting a noise covariance matrix representing the noise covariance based on the channel coefficient covariance and an estimation error covariance determined for the RAKE fingers.

69. The mobile terminal of claim 55, wherein the RAKE receiver circuit is configured to compute RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics by:

scaling a channel coefficient measurement vector based on channel coefficient and estimation error cross-correlation determined for the RAKE fingers; and

using the scaled channel coefficient measurement vector and a noise correlation matrix determined for the RAKE fingers to solve for the combining weights.

70. The mobile terminal of claim 55, wherein the RAKE receiver circuit is configured to determine channel coefficient statistics by determining means of the channel coefficients based on smoothing the channel estimates.

71. The mobile terminal of claim 70, wherein the RAKE receiver circuit is configured to smooth the channel estimates by smoothing values in a channel estimate coefficient vector according to an exponential smoothing filter.

72. The mobile terminal of claim 55, wherein the RAKE receiver circuit is configured to determine channel coefficient statistics by determining channel coefficient statistics across the RAKE fingers such that combining weight generation is compensated for correlations in channel coefficients across the RAKE fingers.

73. The mobile terminal of claim 72, wherein the RAKE receiver circuit is configured to determine the channel coefficient statistics based on nominal channel coefficient statistics corresponding to one or more default fading models.

74. The mobile terminal of claim 73, further comprising a memory circuit to store data corresponding to the one or more default fading models.

75. The mobile terminal of claim 55, wherein the RAKE receiver circuit is configured to process signals from two or more receiver antennas.

76. The mobile terminal of claim 75, wherein the RAKE receiver circuit is configured to determine combining statistics by determining noise and estimation error correlations and channel coefficient correlations jointly across the receiver antennas.

77. The mobile terminal of claim 75, wherein the RAKE receiver circuit is configured to determine combining statistics by determining noise and estimation error correlations separately for each receiver antenna and to determine channel coefficient correlations jointly across the receiver antennas.

78. The mobile terminal of claim 75, wherein the RAKE receiver circuit is configured to assign a set of RAKE fingers to a received signal from each receiver antenna and determine the combining statistics separately for each set of RAKE fingers.

79. The mobile terminal of claim 55, wherein the received signal comprises signals received from two or more transmit antennas.

80. The mobile terminal of claim 79, wherein the RAKE receiver mobile terminal is configured to determine the combining statistics by determining noise and estimation error correlations and channel coefficient correlations jointly across the signals from the two or more transmit antennas.

81. The mobile terminal of claim 79, wherein the RAKE receiver circuit is configured to determine the combining statistics by determining noise and estimation error correlations separately for each transmit antenna and determining channel coefficient correlations jointly across the signals from the two or more transmit antennas.

82. The mobile terminal of claim 79, wherein the RAKE receiver circuit is configured to assign a set of RAKE fingers to a received signal corresponding to each transmit antenna and determine the combining statistics separately for each set of RAKE fingers.

83. A base station for use in a wireless communication network comprising:

a transmitter to transmit wireless signals to one or more remote receivers;

a receiver to receive wireless signals from one or more remote transmitters, said receiver comprising a RAKE receiver circuit configured to:

obtain individual finger output signals by despreading a received signal in each of two or more RAKE fingers;

generate channel estimates corresponding to the RAKE fingers;

determine combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers; and

compute RAKE combining weights for combining the individual finger output signals from the RAKE fingers into a RAKE combined signal based on the channel estimates and the combining statistics.

84. The base station of claim 83, wherein the RAKE receiver circuit comprises a channel coefficient estimator configured to estimate channel coefficients for the RAKE fingers, a channel coefficient statistic estimator configured to estimate channel coefficient statistics, and a noise and error statistic estimator configured to estimate noise and channel estimation error statistics.

85. The base station of claim 84, wherein the RAKE receiver circuit further comprises a combining weight generator to compute the RAKE combining weights.

86. The base station of claim 83, wherein the RAKE receiver circuit is configured to determine combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers by estimating correlations of channel coefficients across the RAKE fingers, and determining estimation error and noise correlations across the RAKE fingers.

87. The base station of claim 83, wherein the RAKE receiver circuit is configured to determine combining statistics comprising channel coefficient statistics, channel estimation error statistics, and noise statistics for the RAKE fingers by estimating means of the channel coefficients for the RAKE fingers, and determining estimation error covariance and noise covariance across the RAKE fingers.

88. The base station of claim 87, wherein the RAKE receiver circuit is configured to determine combining statistics further by determining channel coefficient covariance across the RAKE fingers.

89. The base station of claim 83, wherein the RAKE receiver circuit is configured to generate channel estimates corresponding to the RAKE fingers by smoothing despread pilot values.

90. The base station of claim 89, wherein the RAKE receiver circuit is configured to determine noise statistics comprises determining noise cross-correlation based on the despread pilot values and to scale the noise cross-correlation based on a smoothing factor to obtain an estimation error cross-correlation as the channel estimation error statistics.

91. The base station of claim 83, wherein the RAKE receiver circuit is configured to generate channel estimates corresponding to the RAKE fingers by generating channel estimates from a received pilot signal, and wherein the RAKE receiver mobile terminal is configured to determine noise statistics for the RAKE fingers by generating a noise cross-correlation matrix from the received pilot signal.